MECHANICAL SILO UNLOADERS FOR UPRIGHT SILOS

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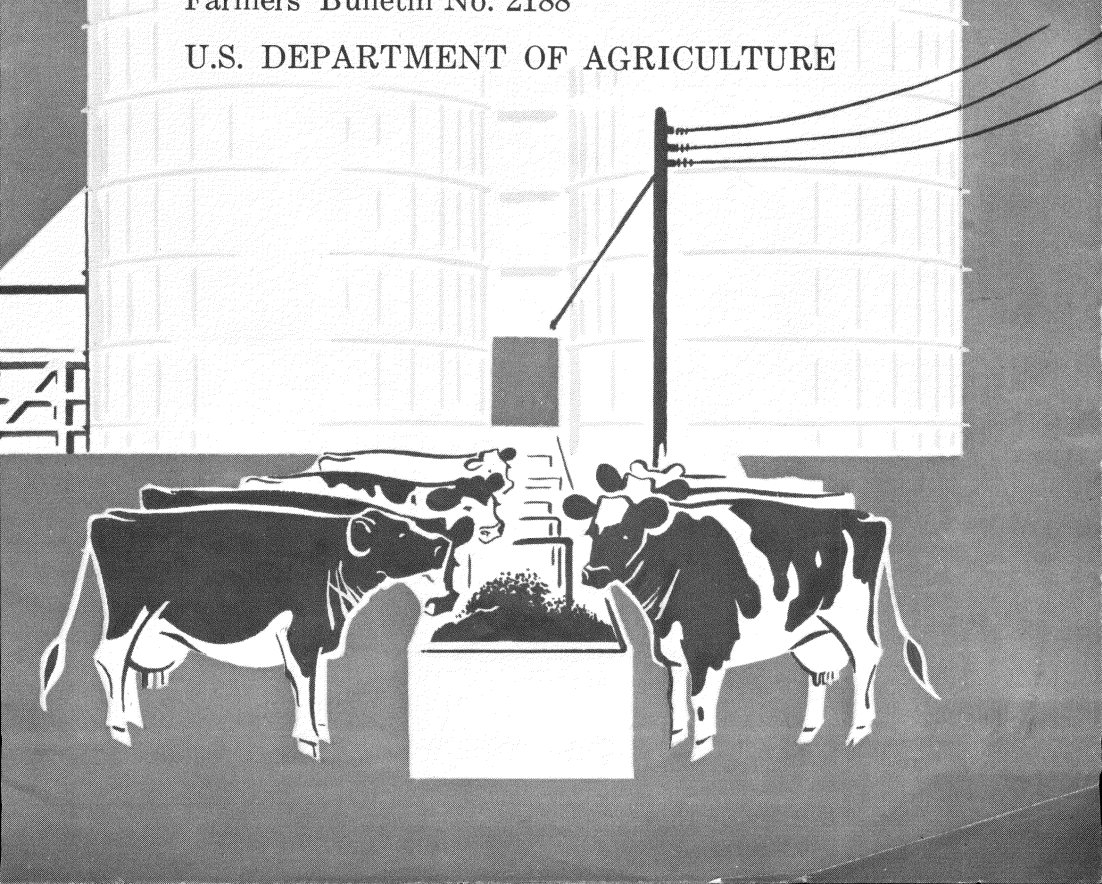

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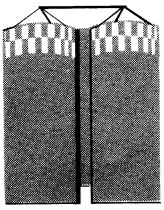

MECHANICAL SILO UNLOADERS FOR UPRIGHT SILOS

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Hand unloading of silage from upright silos is a laborious and sometimes hazardous chore.

Mechanical silo unloaders powered by electric motors—

- Eliminate most of the labor.
- Save trips up and into the silo.
- Unload well-mixed silage, which stock find more palatable.
- Remove silage in a thin, uniform layer, which reduces the chance of spoilage during the period between feed removals.

Two general types of silo unloaders are manufactured—top unloading and bottom unloading.

Top unloaders, which are the type in general use, are installed in and unload silage from the top of the silo, moving downward as unloading progresses. They work, or can be adapted to work, in practically any silo.

Bottom unloaders are installed in and unload silage from the bottom of the silo. They fit only special silos made by the same manufacturer that makes the unloader.

DESCRIPTION

Top Unloaders

Top unloaders are made by a number of manufacturers. The different makes may vary somewhat in design, but all perform the same operations of cutting the silage loose, conveying it to a central point, and discharging it from the silo.

Figures 1 and 2 show two makes of top unloaders. The discussion of essential features which follows includes variations in design.

Suspension and Drive

Two types of top unloaders are available—suspended and surface riding.

Suspended units usually are supported by a cable-and-pulley assembly attached to a tripod installed at the top of the silo (fig. 3).

The supporting cable runs down the outside of the silo and winds on a winch (fig. 4) attached to the silo

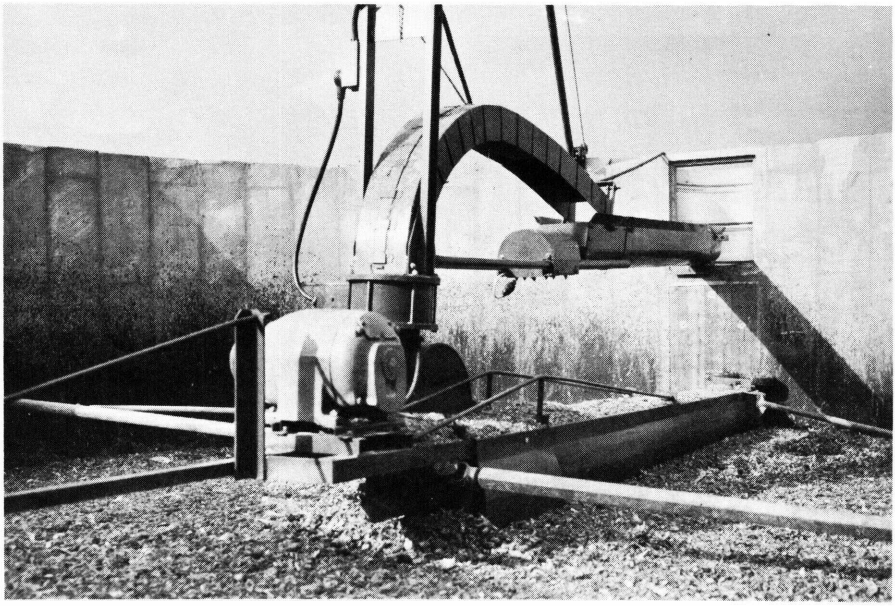

Figure 1.—Suspended-type silo unloader. The unloader discharges silage into an auger conveyor, which carriers it to the chute. The conveyor is powered by a separate motor.

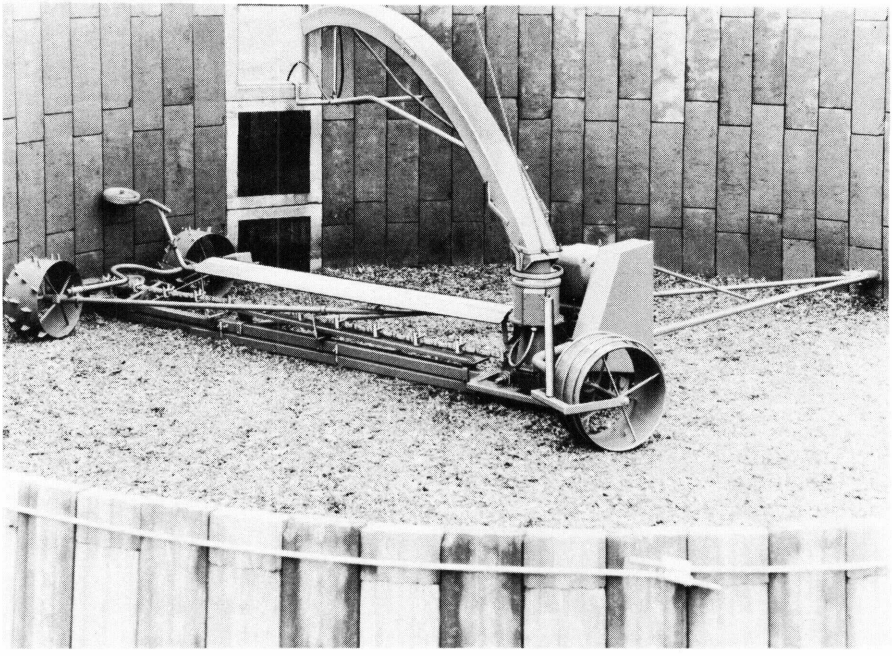

Figure 2.—Surface-riding silo unloader. This make has a chain-type gathering mechanism.

at ground level and at a height convenient for operation of the winch. The operator raises and lowers the unloader by means of this winch. The distance he lowers it into the silage determines the depth of cut and, therefore, the discharge rate. In automatic systems, a small motor (about 1/15 horsepower) powers the winch (fig. 4). Lowering of the unloader is regulated so that it will not bite too deeply, become overloaded, and bog down.

Surface-riding unloaders are supported by three or four wide-rimmed wheels that ride on the surface of the silage. Depth of cut and, therefore, discharge rate, depend on the difference in the setting between the leading and trailing wheels supporting the gathering mechanism.

Top unloaders are powered by one or two electric motors. Continuous, even rotation is provided by (1) weighted drive wheels or drums on a long arm, (2) drive wheels mounted at the outer end of the gathering mechanism, or (3) a meshing drive gear in a large fixed steel ring held up by cables.

Manufacturers usually furnish instructions for installing unloaders. The tripod for a suspended type unloader should be installed when a new silo is built or when an old silo is full.

Gathering Mechanism

The gathering mechanism, or gathering arm as it is frequently called, rotates around the silo and cuts the silage loose and conveys it to the discharge unit.

Most makes of unloaders use augers as the gathering mechanism. Some use one auger; others have a pair of counterrotating augers. Small cutting knives are sometimes bolted to the auger flighting to aid in cutting frozen, hard-packed silage or breaking up pads of grass silage.

Several makes of unloaders use a chain, similar to that on a chain saw, as the gathering mechanism. The chain has small paddles on spiked teeth which loosen the silage and drag it to the discharge point.

All unloaders have special cutting equipment on the wall end of the gathering mechanism to remove frozen silage from the silo walls.

Discharge

Most makes of unloaders discharge the silage through a curved or "gooseneck" spout and out the silo-chute doors. Method of moving the silage from the gathering mechanism up through the spout varies with different makes.

Some use a type of flywheel with paddles attached to it. The combined action of the paddles and flywheel both throws and blows the silage up through the spout.

Other makes have a rotary impeller with swinging hammers or paddles which throw the silage up through the spout. Most of these units use auxiliary discharge equipment in silos 16 feet in diameter or larger. The auxiliary equipment may be a booster-blower in the discharge spout or an auger conveyor powered by a separate motor. In the latter case, the silage drops from the spout into the conveyor which carries it out the chute door.

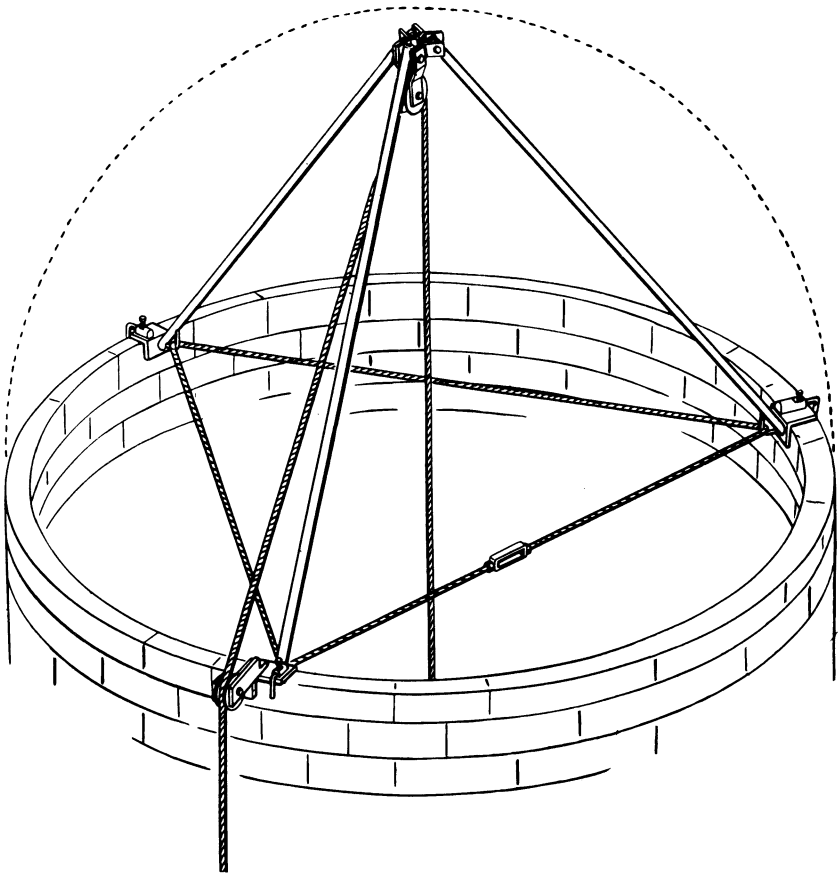

***Figure 3.*—A tripod installed at the top of the silo supports the suspended-type silo unloader.**

One make which has a chain-type gathering mechanism also uses the chain to throw the silage up through the spout.

One make of unloader discharges the silage down through a hole in the material where it drops into a conveyor at the bottom of the silo (fig. 5). The hole is formed at the time the silo is filled by pulling a steel plug through the silage. The silage is withdrawn from the silo by a conveyor at the bottom of the silo.

Bottom Unloaders

Bottom unloaders (fig. 6) perform the same operations as top unloaders—cut the silage loose, convey it to a central point, and discharge it from the silo.

Bottom unloaders are fixed in the bottom of the silo during the unloading operation. An unloading arm which includes a heavy endless chain (similar to the chain on a chain saw) slowly rotates around the silo. As the arm ro-

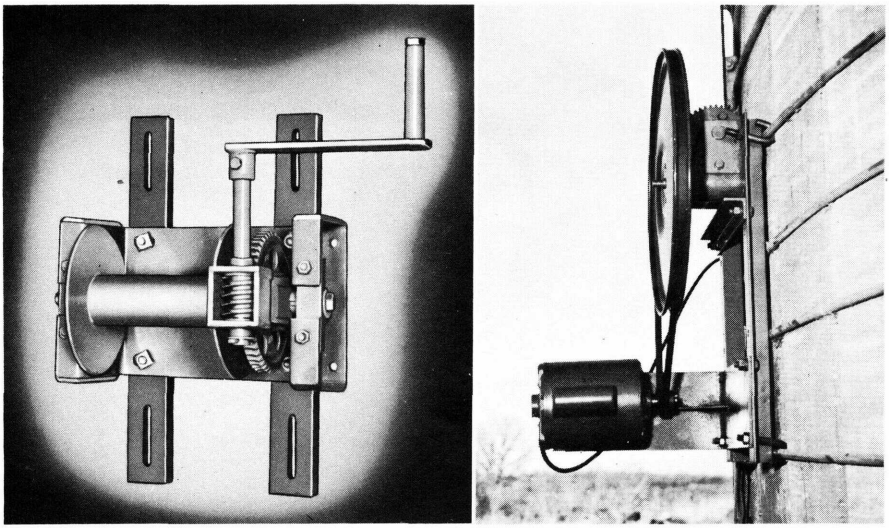

***Figure 4.*—Manually operated winch (left) and power winch (right) for raising and lowering a suspended-type silo unloader.**

tates, the chain claws the silage loose and drags it to the center. There the silage drops into a conveyor which carries it to the outside. As the unloading progresses, the silage continually settles.

Bottom unloaders offer several advantages:

- Motor and drive unit are at ground level outside the silo and readily accessible for adjustment, servicing, or repair. (The unloading unit itself, however, is not as accessible as is that of a top unloader.)
- The first silage placed in the silo is the first to be unloaded.
- It is not necessary to climb the silo to open chute doors.
- The silo can be filled without moving the unloader, whereas a top unloader must be raised or removed. However, recommended procedure is to remove the unit when loading forage into an empty silo and leave it in when loading corn. Once the silo is partly filled and silage is being unloaded daily, more silage can be added without removing the unit.

ELECTRIC MOTORS

Most manufacturers of silo unloaders supply motors with their equipment. Some may not, however, and you will have to furnish your own. Or, you may eventually have to replace a motor. In either case, it is important to select the right type and size and to install it correctly.

Selection

Type

Most farms have single-phase, 120/240-volt electric service. For this reason, single-phase motors are

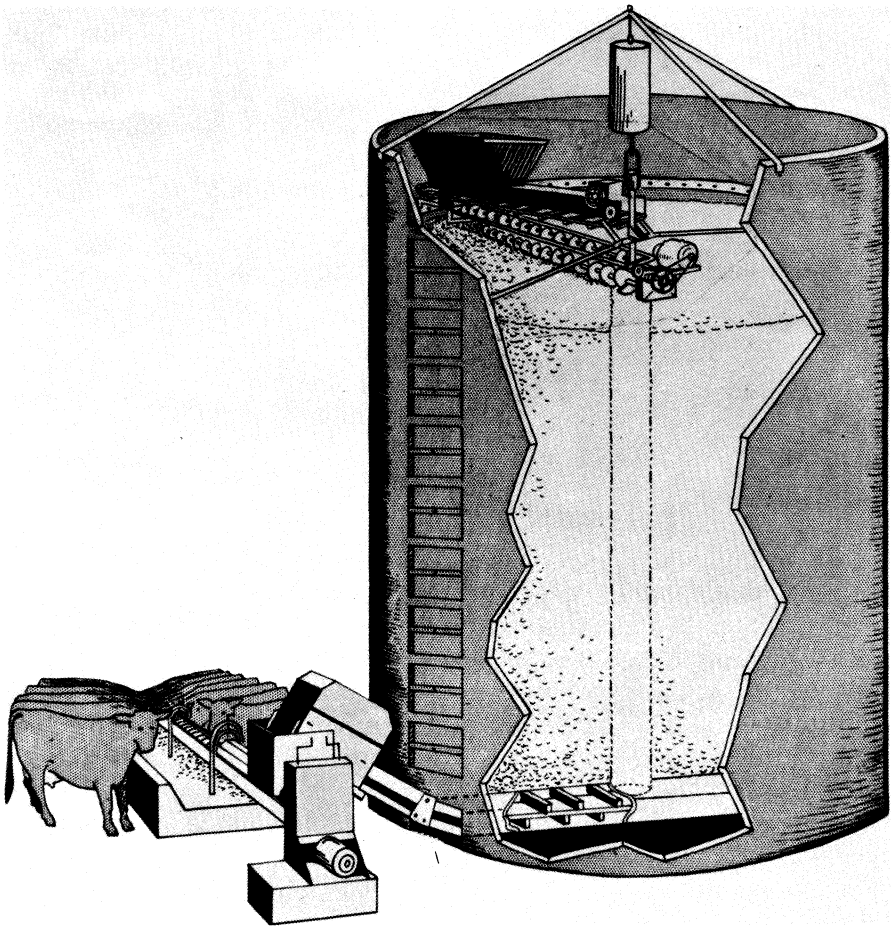

***Figure 5.*—One make of silo unloader discharges the silage down through a hole in the material.**

commonly used to power farm equipment.[1]

Some farms may have three-phase electric service. Three-phase motors are recommended for silo unloaders when the power is available. In sizes of 1 horsepower or larger, they generally cost slightly less to operate and are more efficient than single-phase motors. Also, they are more simply constructed and require less maintenance.

Single-phase repulsion start-induction run motors are commonly used for silo unloaders. They have the high starting torque with low starting current required for unloader operation.

Specially designed capacitor mo-

[1] For additional information on single-phase electric motors, see USDA Farmers' Bulletin 2177, "Single-Phase Electric Motors for Farm Use."

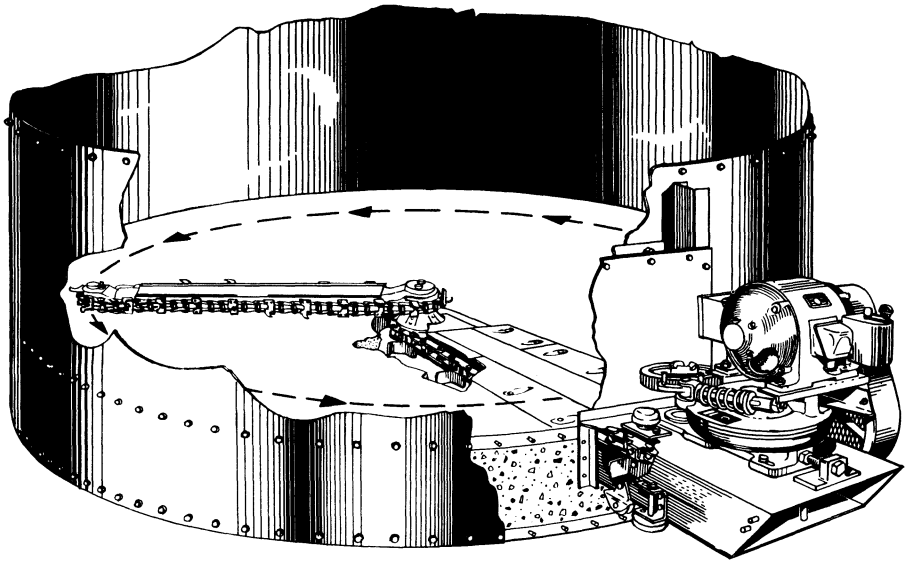

***Figure 6.*—Bottom unloaders, which fit only special silos, unload silage from the bottom of the silo.**

tors which have high starting torque are available for operating silo unloaders. Wiring for these motors—and all motors—must be of the correct size to insure adequate voltage during operation (see table on p. 11). Capacitor motors generally require less maintenance than repulsion motors.

Size

Main drive motors of silo unloaders usually range in size from 3 to 7½ horsepower. Large units may have motors up to 10 horsepower. NOTE: Some power suppliers may limit motor size on single-phase service. Check with your power supplier before using larger motors.

Some makes of unloaders use an additional ½- to 1-horsepower capacitor motor to power a booster blower in the discharge spout or to propel the gathering mechanism around the silo. Where a separate auger unit conveys the silage from the discharge spout to the chute door, a ½- or ¾-horsepower capacitor motor powers the auger.

The size of main drive motor needed depends roughly on silo size, as follows:

Silo diameter, feet	*Motor size, horsepower*
Up to 14	3–5
15 to 20	3–7½
Over 20	5–10

Operating conditions may permit or require the use of different size motors in each case.

For example, under good conditions, a 3-horsepower motor should satisfactorily operate an unloader in a 14-foot silo. But if the silage is

frozen or hard packed, a 5-horsepower motor would do a better job.

You may want to use a larger motor merely to increase the discharge rate without overloading.

In some cases, 3-horsepower motors are satisfactorily operating unloaders working in silos up to 20 feet in diameter. This is possible because a large silo actually may have a lower proportion of frozen silage than a small one.

Duty Cycle

Some manufacturers supply limited-duty motors with their silo unloaders; others supply continuous-duty motors. Limited-duty motors will run for a specified period of time—usually 30 to 60 minutes—under full load before overheating. Continuous-duty motors will run indefinitely under full load without overheating. An enclosed motor will heat up faster than a dripproof motor with the same frame.

The type needed depends on the length of time the unloader will be in continuous operation.

Environmental conditions affect the length of time a limited-duty motor will operate satisfactorily. Since conditions vary throughout the country, it is advisable to consult your power supplier about operating limited-duty motors.

Consider future operation in selecting the motor. A limited-duty motor may be satisfactory at first, but if you increase your feeding operation later, it may not be adequate.

Frame

Motors are available with different types of frames or housings—open, dripproof or splashproof, totally enclosed, and explosion-proof.

Silo unloaders frequently operate in a cold, moist atmosphere and are sometimes exposed to the weather. Totally enclosed motors are recommended for protection against the entrance of moisture and silage particles. Some moisture may get in, but usually the motors have drip holes with plugs for draining. *Always remove the plugs.* Motors not equipped with drain plugs may have small holes drilled in the frame by the manufacturer of the silo unloader.

Several manufacturers supply dripproof motors with their unloaders. If screened, the motors will be well protected against the entrance of silage particles, although some may get in.

Installation

Installation of the motor—wiring, controls, and protective devices—should meet the requirements of the National Electrical Code and local ordinances.

Installation by a qualified electrician and inspection by the power supplier are recommended.

Wiring

Wiring from the service entrance to the motor must be of the correct size. Check the ampere rating of the motor. If the wire is too small, voltage will be less than that for

which the motor was designed. Low voltage causes a motor to draw excessive current and overheat.

The accompanying table shows the proper size wire for motors located various distances from the service entrance. The distance from the service entrance to the motor should be measured accurately, not estimated. CAUTION: Be sure that operation of the silo unloader will not overload the circuit. A separate service entrance may be required.

Protection

Motors must be protected against overload. Overloading causes overheating, which can seriously damage a motor. For each 18° F. increase in temperature above rated operating temperature, the life of the insulation on motor windings is cut in half.

Common causes of overload and overheating include low voltage, load too great, driven equipment locked or jammed, worn motor bearings, and drive belts too tight or pulleys not alined.

Good overload protection for motors and wiring circuits includes:

- *Built-in overload protectors in the motors* to protect against continued overloads. Two types are available—manual reset and automatic reset. Manual reset is recommended. Motors with automatic reset will restart automatically when the protective device cools. This could be dangerous if you are working on the equipment to correct the cause of overload. Low temperatures have been known to change some manual overload protectors to automatic. Therefore, all motors must be taken off the line by means of a switch whenever work on unloaders is undertaken.
- *An ammeter* wired into the circuit to indicate excessive current when the equipment is overloaded. This will allow you to operate the equipment at full capacity without overloading. A fused "start-stop" control with ammeter is now available (fig. 7).
- *A current-sensitive breaker* which will trip out before the built-in protector on the motor if

Mimimum wire size for silo unloader motors—single-phase, 230 volts

Motor horsepower	Full-load amperes	Flexible cable-control to motor (100 feet).	Distance in feet from service entrance to control							
			50	100	150	200	250	300	400	500
		AWG size	Wire size [1]							
2	12	10	10	10	10	10	8	8	6	6
3	17	8	8	8	8	8	6	6	4	4
5	28	8	8	8	6	4	3	------	------	------
5	28	6	------	------	------	6	4	4	3	2
7½	40	6	6	6	4	4	2	2	------	------
7½	40	4	------	------	------	------	4	4	2	------

[1] Larger wire is used from main service or transformer to service entrance.

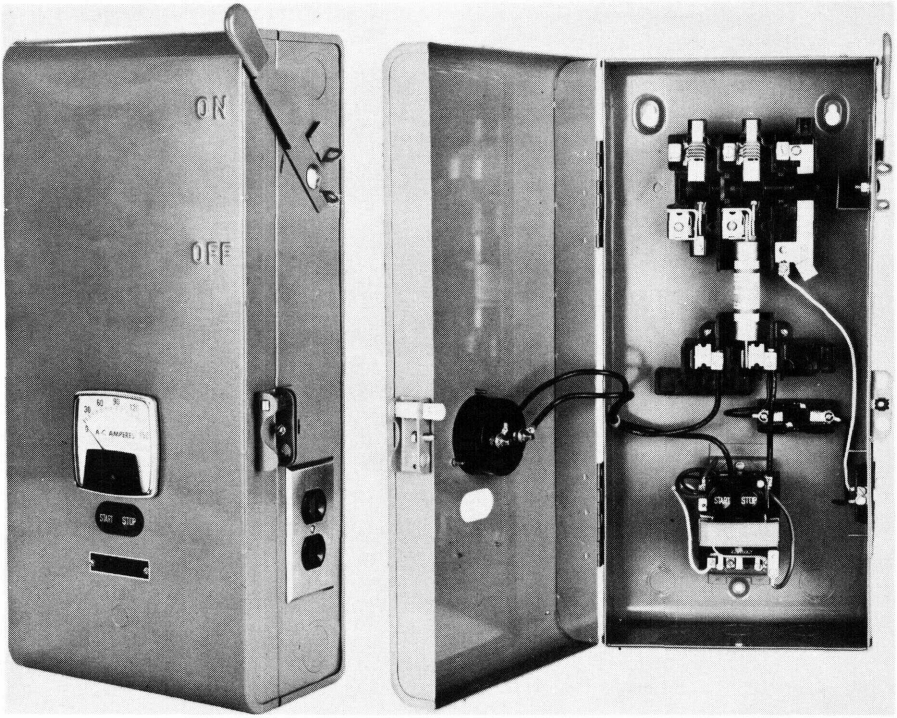

***Figure 7.*—Fused start-and-stop control switch with ammeter. Left, external view; right, internal view.**

the motor stalls. This will save you from having to climb the silo to reset the built-in device.

- *A safety switch* with standard fuses or dual-element time-delay fuses to protect the wiring and equipment against overload and fire in case of shorts.

OPERATION

As with any mechanical equipment, the different makes of silo unloaders vary in efficiency. Some unload silage at a faster rate than others and some require more power than others. But all should perform satisfactorily if operated properly.

Differences in operating conditions will cause variations in unloading rate and power requirement of unloaders. For example, under normal conditions, an unloader powered by a 5-horsepower motor and working in a 16-foot silo may average 7½ tons per hour. But if the silage is frozen, the unloading rate may drop considerably.

You can insure maximum performance from your equipment by following recommended practices.

Operating Conditions

Some silage materials are easier to unload than others. Corn, for example, unloads almost twice as fast as grass and alfalfa. Unload-

ing very fine silage material, such as cob meal or ground corn, increases power requirement considerably.

If wet, frozen, or hard packed, silage is hard to unload, and the discharge rate may drop and the power requirement increase. Very wet silage may clog the discharge mechanism, or it may be too heavy for the discharge unit to throw clear of the door. Silage with a moisture content of 68 to 70 percent is satisfactory for mechanical unloading.

Length of cut of the silage can affect unloader operation. Long pieces of silage material, such as grass, may wrap around augers. Very finely chopped silage may clog the discharge mechanism or stick in the discharge spout. Forage silage cut ¼ to ⅜ inch in length should unload satisfactorily and should also pack better and have less spoilage.

Density of the silage increases from top to bottom in a silo. Silage at the top may be only one-third as dense as that at the bottom. As unloading progresses, the increase in density will affect unloading rate and power requirement.

The manner in which the operator handles the unloader can affect performance. Overloading can cause motors to overheat and cut out. (If the overload protective device fails to function, the motor may be damaged.) On some unloaders, the gathering mechanism may be capable of conveying more material to the discharge unit than the latter can handle. If the gathering mechanism is lowered into the silage too fast it may bring in enough material to clog the discharge unit.

Recommended Practices

These general practices should be followed to obtain maximum performance from the silo unloader:

- Read and follow carefully all installation, operation, and maintenance instructions in the manufacturer's manual that comes with the unloader.
- Fill the silo uniformly. This will reduce the number of hard and soft spots in the silage which hamper unloader operation and eliminate air leaks which cause decay. Use of some type of silage distributor is recommended. (One make of unloader doubles as a silage distributor.) Uniform filling also increases the capacity of the silo.
- Protect the silage from excessive moisture. This includes preventing moist air from a barn or other building attached to the silo from venting up the silo chute.
- Keep the unloader properly adjusted. Adjustment of various components may be necessary as operating conditions change.
- Unload wet or decayed silage on top by hand. Such material is hard to unload and may clog the discharge unit of the unloader.
- At first, run a suspended-type unloader slightly above the silage so that it can cut down high spots. Lower it into the silage slowly to prevent sudden overload.
- Unload at approximately the same rate each time you operate the unloader. Frozen-silage cutting knives on the wall end of the gathering arm usually are set according to the delivery rate. If the delivery rate fluctuates, they may not cut properly.

- Inspect unloader operation at regular intervals. A convenient time is when you climb the silo to open chute doors. Make necessary adjustments immediately.
- Avoid overloading motors. Motors usually can handle overloads for a short period, but continuous overloading causes overheating, which can damage a motor. An ammeter wired into the circuit can indicate overloading. If the ammeter registers excessive current, raise the unloader off the silage until the current drops.
- After each operating period, raise the suspended-type unloader off the silage so that it can clear itself of material. (Surface-riding unloaders are designed for self-clearing by special operation.) Keep the unloader suspended until the next operating period so that it will not freeze in the silage and will not have to start under load.

Automatic Operation

Mechanical silo unloaders may be used efficiently as an integral part of an automatic feeding operation.

Electrical controls may be installed to make unloader operation automatic. You merely push a button or flip a switch to start the equipment, and the controls automatically lower the unloader into the silage, regulate its operation so that there is uniform discharge of silage material, and raise it when the unloading cycle is completed.

Automatic operation eliminates the need for the operator to stand guard. Time then is not important. Delivery rate can be reduced allowing use of smaller motors.

Automatically controlled unloaders usually discharge only 50 percent as much silage in a given period of time as do unloaders that are manually controlled.

Moving to Another Silo

Silo unloaders are built so that they can be easily disassembled and moved from one silo to another. Some manufacturers offer extension kits which can be added to their unloader to adapt it to larger silos.

Bottom unloaders can be moved to another silo of the same type without disassembly. If the second silo is full, the unloader should be positioned and operated, and it will "eat" its way in as it is pushed in.

Where two or more silos of equal height are in line and not more than a few feet apart, a monorail track can be erected between silos at the top to facilitate moving top unloaders (fig. 8). Some manufacturers of silo unloaders offer construction plans and assistance in building a track.

COST

Silo unloaders range in price from about $1,000 to more than $2,500, the price depending on make and size. The price generally includes the motor or motors.

Cost of operating an unloader cannot be determined precisely; it depends on such factors as efficiency of the equipment, operating conditions (for example, kind of silage), and manner in which the equipment is operated.

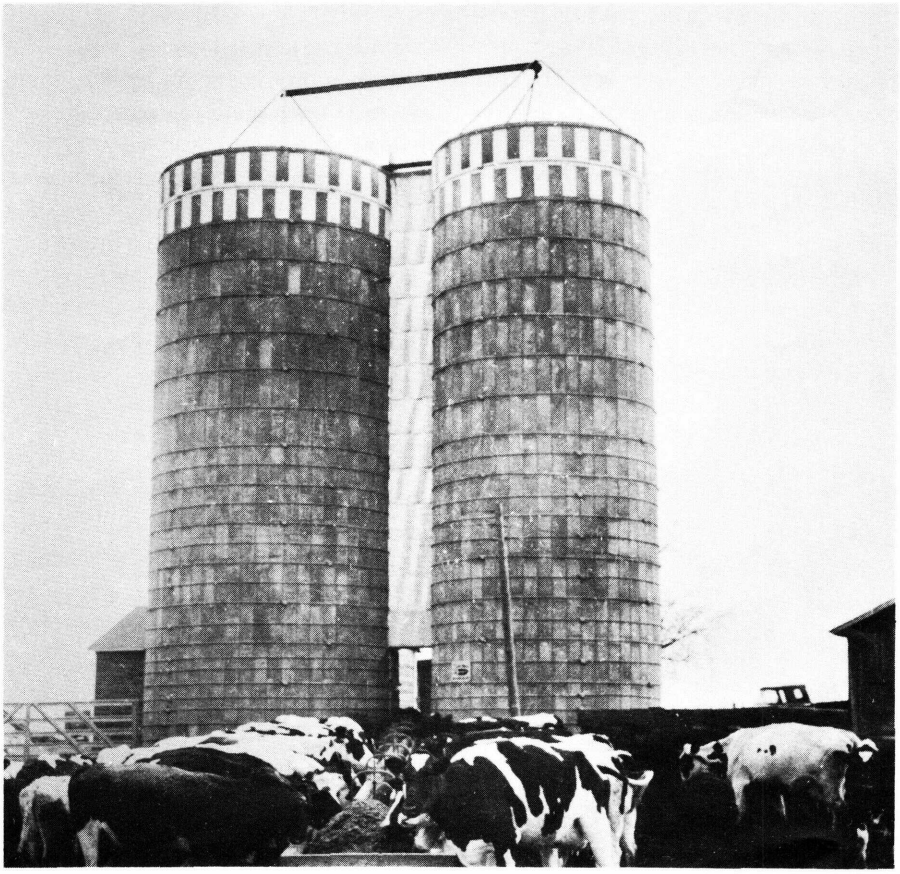

***Figure 8.*—A monorail between silos, at the top, facilitates moving the unloader from one silo to another.**

Estimated cost of unloading 200 tons of hay silage per year with a top unloader is 80 cents per ton (figured on a 10-year basis at these costs: unloader, $1,000 or $100 per year; wiring, $200 or $20 per year; repairs $30 per year; and electricity, 3¢ per ton of silage unloaded). The cost drops, however, as the amount of silage handled increases. Estimated cost of unloading 1,200 tons of hay silage per year is about 40 cents per ton.

Silo unloaders are a good investment for large feeding operations. For small operations, they may not be as economical as unloading silage manually, but they will save labor.

In a study in Virginia involving 62 upright silos, 0.3 man-hours per ton were required to unload silage by hand. When 8 mechanical unloaders were used in 14 silos, 0.04 man-hours per ton were required, which included 8 hours required to move unloaders to additional silos on each of 5 farms. Labor saved was about one-fourth man-hour per

ton (additional labor saving is possible when the silage is frozen). However, it is necessary to stay close by the silo while the unloader is operating.

An important factor to consider in deciding whether or not to use an unloader is physical condition. Climbing into and out of a silo and unloading silage by hand are strenuous and, sometimes, hazardous. Older persons or those in other than good physical condition may find an unloader a necessity.

Before buying an unloader, visit several farms where late models are in use. Keep in mind that a high unloading rate from an unloader does not necessarily indicate efficient performance. Some operators may tend to overload their equipment, which will increase discharge rate, but may also damage motors or unloader.

Illustrations are by courtesy of the following companies:
Figures 1, 4 (*left*), and 8: Badger Northland, Inc.
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Figure 4 (*right*): Van Dusen and Company, Inc.
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